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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/047,455	01/15/2002	Edwin L. Piner	N00400/70013 RJP/RHW	1054
23628	7590	03/17/2005	EXAMINER	
WOLF GREENFIELD & SACKS, PC FEDERAL RESERVE PLAZA 600 ATLANTIC AVENUE BOSTON, MA 02210-2211			HU, SHOUXIANG	
			ART UNIT	PAPER NUMBER
			2811	

DATE MAILED: 03/17/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

EX

Office Action Summary

Application No.

10/047,455

Applicant(s)

PINER ET AL.

Examiner

Shouxiang Hu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 December 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6, 12-32 and 39-44 is/are pending in the application.
- 4a) Of the above claim(s) 6, 23-28, 31 and 32 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-5, 12-22, 29, 30 and 39-44 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Claims 6, 23-28 and 31-32 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the 12-20-2004 Election.

Applicant's election of Species 3 with traverse in the above Election is acknowledged. The traversal is on the ground(s) that search and examination of all claims would place no undue burden on the examiner. This is not found persuasive because the pending claims drawn to a product are mainly directed to a substrate structure with a gallium nitrite layer formed thereabove. Such a substrate structure may have various structural and/or material variations and application, including but not limited to the various species corresponding to Figs. 1-10. The substantially broad subject matters of these claims may be relevant to Class/Subclasses including: 257/12-28, 79-103, 183-201, 347-354 and 499-527. A thorough search is required in each of these Class/subclasses along with key word search for the search and examination of all of the claims; and which would impose a substantially undue burden upon the examiner.

And, it is further noted that, upon the allowance of any elected independent claim, applicant will be entitled to consideration of claims to additional species which are

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written in dependent form or otherwise include all the limitations of the allowed independent claim.

The requirement is still deemed proper.

Accordingly, claims 1-6, 12-32 and 39-44 are pending in this application; and claims 1-5, 12-22, 29-30 and 39-44 remain active in this office action.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 17, 18 and 44 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The original disclosure lacks an adequate description about the combination of the subject matters of a SiGe layer on a silicon substrate or underlying an intermediate layer and the subject matters of the recited "X" is equal to 0.7 or 0.8, as normally it requires X to be approximately 1 at the lower portion of the SiGe layer in order to achieve adequate lattice match therebetween, or a good lattice match to the overlying intermediate layer.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1-3, 5, 19-21 and 39-41 are rejected under 35 U.S.C. 102(b) as being anticipated by Ito (WO98/44569; also see US 6,583,442 for its English translation).

Ito discloses a semiconductor structure (see US 6,583,442; Fig. 1, col. 3, lines 45-52, and col. 4, lines 1-10), comprising: a silicon germanium component or layer (at least the top portion of the substrate layer similar to layer 101 in Fig. 1); a gallium nitride material component or layer (similar to layer 102, 103, and/or 104); and, an intermediate layer (at least the layer 102; GaN, or a bottom portion of it).

Regarding claims 3 and 5, at least the bottom portion of the SiGe substrate layer (101) can be regarded as a silicon germanium substrate.

Regarding claims 19-21, the gallium nitride material component in Ito can be $\text{Al}_x\text{In}_y\text{Ga}_{(1-x-y)}\text{N}$ alloy, with the sum of $(x+y)$ being less than 0.2 or being zero (see col. 4, lines 1-3).

6. Claims 1-3, 5, 15, 19-21 and 39-41 are rejected or further rejected under 35 U.S.C. 102(b) as being anticipated by Hata (WO98/42030; also see US 6,417,525 for its English translation).

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Hata discloses a semiconductor structure (see US 6,417,525; similar to Fig. 1a, also see col. 3, lines 11-17), comprising: a silicon germanium component or layer (at least the top portion of the substrate layer similar to layer 1 in Fig. 1a); a gallium nitride material component or layer (3 and/or 4); and an intermediate layer (2 and/or at least a lower portion of layer 3).

Regarding claims 3 and 5, at least the bottom portion of the SiGe substrate layer (1) can be regarded as a silicon germanium substrate.

Regarding claim 15, it is noted that a substrate for epitaxially growing compound layers such as the one in Hata is commonly formed of a single crystal layer.

Regarding claims 19-21, the gallium nitride material component in Hata can be $\text{Al}_x\text{In}_y\text{Ga}_{(1-x-y)}\text{N}$ alloy, with the sum of $(x+y)$ being less than 0.2 or being zero (such as GaN).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ito.

The disclosure of Ito is discussed as applied to claims 1-3, 5, 19-21 and 39-41 above.

Although Ito does not expressly disclose that the SiGe substrate can have a monocrystalline structure, office notice is taken that that single crystal SiGe substrate is an art-recognized common substrate for achieving good performance in devices formed thereon, compared with that of non-single crystal one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with the SiGe layer having a monocrystalline structure, so that a device formed thereon with good performance would be obtained.

9. Claims 4, 13, 14, 30, 43 and 44, as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Bulsara et al. ("Bulsara"; US 6,589,335).

The disclosure of Ito is discussed as applied to claims 1-3, 5, 15, 19-21 and 39-41 above.

Although Ito does not expressly disclose that the SiGe can be graded and formed on a silicon substrate, one of ordinary skill in the art would readily recognize that a silicon substrate can be desirably used for lower the cost, and that a graded SiGe layer can help to improve the lattice match between the silicon substrate and a III-V epitaxial layer, as evidenced in Bulsara (see the Ge-increasing graded GeSi layer 104 on the silicon substrate 102 in Fig. 1A).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the Si-based graded SiGe layer of Bulsara

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into the semiconductor structure of Ito, so that a structure having improved quality in the Gallium nitride layer would be obtained with low cost.

Regarding claim 44, it is further noted that the specific composition ration between Si and Ge is an art recognized important result-oriented parameter subject to routine experimentation and optimization, as further evidenced in Redwing et al. (US 5,874,747; of record; see col. 18, line 39 through col. 19, line 4). It then would be well with the ordinary skill in the art to form the above collectively taught structure with the recited composition ratio, so as to form a structure with better lattice match between the SiGe layer and the GaN layer therein

10. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Redwing et al. ("Redwing"; US 5,874,747).

The disclosure of Ito is discussed as applied to claims 1-3, 5, 15, 19-21 and 39-41 above.

Although Ito does not expressly disclose that the structure can further include a graded intermediate layer, one of ordinary skill in the art would readily recognize that the an graded intermediate layer can be desirably formed on a substrate recognize that a graded intermediate layer can be desirably formed on a substrate before the expitaxial growth of the overlying gallium nitride layer for improving the lattice match and thermal match therebetween, as evidenced in Redwing (see col. 18, line 39 through col. 19, line 4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with a graded intermediate layer being included, as taught in Redwing, so that a structure with high quality Gallium nitride layer would be obtained through improved good lattice match and thermal match.

11. Claims 16-18, 22 and 29, as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Haga et al. ("Haga"; US 5,403,673).

The disclosure of Ito is discussed as applied to claims 1-3, 5, 15, 19-21 and 39-41 above.

Although Ito does not expressly disclose that the SiGe and gallium nitride components (or layers) can have a thermal match of within +/- 25%, that the SiGe material can be $\text{Si}_x\text{Ge}_{1-x}$ with x being greater than 0.8, and/or that Gallium nitride material have a crack level of less than $0.005\text{um}/\text{um}^2$, one of ordinary skill in the art would readily recognize that thermal match, crack level in the epitaxial layer and the composition in the underlying layer are all art-recognized parameters of importance subject to routine experimentation and optimization, as that thermal match and low crack level are always desirable for achieving high level device performance (as readily evidenced in the prior art references such as Redwing) and that the quality of the epitaxial gallium nitride layer always depends on the lattice match and thermal match with the underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, which in turn depends on the composition of the

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underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, as evidenced in Haga (see col. 4, lines 43-49, col. 13, line 55 through col. 14, line 13, and col. 14, line 42 –45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with the thermal match being within $\pm 25\%$, with the composition ratio x in $\text{Si}_x\text{Ge}_{1-x}$ being greater than 0.8, and/or with Gallium nitride material having a crack level of less than $0.005\text{um}/\text{um}^2$, through routine experimentation and optimization, as being taught in Haga, so that high quality Gallium nitride layer and high level device performance would be obtained through good lattice match between the expitaxial Gallium nitride layer and the underlying SiGe layer.

12. Claim 22 is further rejected under 35 U.S.C. 103(a) as being unpatentable over Hata.

The disclosure of Hata is discussed as applied to claims 1-3, 5, 15, 19-21 and 39-41 above.

Although Hata does not expressly disclose that the gallium nitride material layer can has a crack level of less then $0.005\text{um}/\text{um}^2$, one of ordinary skill in the art would readily recognize that low crack level is always desirable for achieving high level device performance.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Hata with the crack level in the gallium nitride layer being much less then $0.005\text{um}/\text{um}^2$, so that a

device formed with the gallium nitride having better device performance would be obtained.

In addition, it is noted that any process limitations that may potentially implicated in the making of such low crack level gallium nitride layer would not carry patentable weight in this claim drawing to a structure, because distinct structure is not necessarily produced. In re Thorpe, 227 USPQ 964, 966 (Fed. Cir. 1985).

13. Claims 4, 13, 14, 43 and 44, as being in compliance with 35 U.S.C. 112, are further rejected under 35 U.S.C. 103(a) as being unpatentable over Hata in view of Bulsara et al. ("Bulsara"; US 6,589,335).

The disclosure of Hata is discussed as applied to claims 1-3, 5, 15, 19-22 and 39-41 above.

Although Hata does not expressly disclose that the SiGe can be graded and formed on a silicon substrate, one of ordinary skill in the art would readily recognize that a silicon substrate can be desirably used for lower the cost, and that a graded SiGe layer can help to improve the lattice match between the silicon substrate and a III-V epitaxial layer, as evidenced in Bulsara (see the Ge-increasing graded GeSi layer 104 on the silicon substrate 102 in Fig. 1A).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the Si-based graded SiGe layer of Bulsara into the semiconductor structure of Hata, so that a structure having improved quality in the Gallium nitride layer would be obtained with low cost.

Regarding claim 44, it is further noted that the specific composition ration between Si and Ge is an art recognized important result-oriented parameter subject to routine experimentation and optimization, as further evidenced in Redwing et al. (US 5,874,747; of record; see col. 18, line 39 through col. 19, line 4). It then would be well with the ordinary skill in the art to form the above collectively taught structure with the recited composition ratio, so as to form a structure with better lattice match between the SiGe layer and the GaN layer therein

14. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hata in view of Redwing et al. ("Redwing"; US 5,874,747).

The disclosure of Ito is discussed as applied to claims 1-3, 5, 15, 19-22 and 39-41 above.

Although Hata does not expressly disclose that the structure can further include a graded intermediate layer, one of ordinary skill in the art would readily recognize that the an graded intermediate layer can be desirably formed on a substrate recognize that a graded intermediate layer can be desirably formed on a substrate before the expitaxial growth of the overlying gallium nitride layer for improving the lattice match and thermal match therebetween, as evidenced in Redwing (see col. 18, line 39 through col. 19, line 4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Hata with a graded intermediate layer being included, as taught in Redwing, so that a structure with high

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quality Gallium nitride layer would be obtained through improved good lattice match and thermal match.

15. Claims 16-18 and 22, as being in compliance with 35 U.S.C. 112, are rejected under 35 U.S.C. 103(a) as being unpatentable over Hata in view of Haga et al. ("Haga"; US 5,403,673).

The disclosure of Ito is discussed as applied to claims 1-3, 5, 15, 19-22 and 39-41 above.

Although Hata does not expressly disclose that the SiGe and gallium nitride components (or layers) can have a thermal match of within +/- 25%, and/or that the SiGe material can be $\text{Si}_x\text{Ge}_{1-x}$ with x being greater than 0.8, one of ordinary skill in the art would readily recognize that thermal match and the composition in the underlying layer are all art-recognized parameters of importance subject to routine experimentation and optimization, as that thermal match is always desirable for achieving high level device performance (as readily evidenced in the prior art references such as Redwing) and that the quality of the epitaxial gallium nitride layer always depends on the lattice match and thermal match with the underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, which in turn depends on the composition of the underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, as evidenced in Haga (see col. 4, lines 43-49, col. 13, line 55 through col. 14, line 13, and col. 14, line 42 –45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Hata with the thermal match being within +/- 25%, and/or with the composition ratio x in $\text{Si}_x\text{Ge}_{1-x}$ being

greater than 0.8, through routine experimentation and optimization, as being taught in Haga, so that high quality Gallium nitride layer and high level device performance would be obtained through good lattice match between the epitaxial Gallium nitride layer and the underlying SiGe layer.

Response to Arguments

16. Applicant's arguments filed on May 10, 2004 have been fully considered but they are not persuasive.

Applicant's main arguments include: Ito teaches away from the claimed invention. In response, it is noted that Ito specifically teaches that the substrate can be formed of SiGe (see col. 3, lines 46-50). Furthermore, it is noted that the LED structure shown in cover page figure in Ito can naturally and readily emit light through the top transparent electrode regardless what material the substrate is made of. Moreover, the SiGe substrate of Ito can be naturally regarded as an alloy of Si and Ge which can naturally cover an alloy composition with substantially low Ge, which will render the substrate to be substantially similar to a silicon substrate in optical properties.

Conclusion

17. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is 571-272-1654. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.


Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>.

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SH

March 9, 2005



SHOUXIANG HU
PRIMARY EXAMINER